

SCIENTIFIC NOTE

Nontarget Arthropods Captured in Cue-lure Baited Bucket Traps at Area-Wide Pest Management Implementation Sites in Kamuela and Kula, Hawaiian Islands

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Introduction

An area-wide integrated pest management (AWPM) program began in the Hawaiian Islands in October, 1999 to demonstrate the feasibility of suppressing populations of three economically important species of fruit flies (oriental fruit fly (*Bactrocera dorsalis* (Hendel), melon fly (*Bactrocera cucurbitae* (Coquillett), and Mediterranean fruit fly (*Ceratitidis capitata* (Wiedemann)) (Faust and Chandler 1998; Chandler and Faust 1998). These species of fruit flies were accidentally introduced in the Hawaiian Islands (Back and Pemberton 1917, 1918; van Zwaluwenberg 1947; and Vargas and Nishida 1985). Melon fly population suppression with existing technologies (Steiner et al. 1970; Liquido 1991; McInnis et al. 1994; Purcell and Messing 1996; Peck and McQuate 2000; Vargas et al. 2000; Vargas et al. 2001) began in January 2002. Male annihilation using cue-lure and a toxicant (Cunningham and Steiner 1972) is one of the technologies being employed to suppress male melon flies.

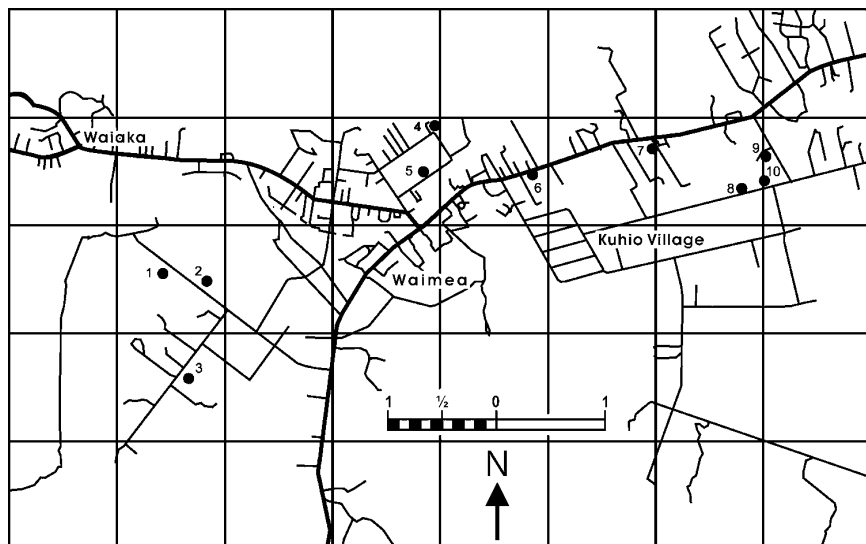
Past concerns in Hawaii about the impact of fruit fly lures on nontarget species (USDA-APHIS 1985), especially endemic Hawaiian species, have prompted research on methyl eugenol and protein hydrolysate bait (Asquith and Messing 1992, Asquith and Kido 1994, Kido et. al 1996, Asquith and Burny 1998, and Howarth and Howarth 2000). In a preliminary study by Loope and Medeiros (1992), nontarget insects, including native Hawaiian *Drosophila*, were captured in cue-lure traps.

The objective of this study was to collect, identify, and categorize field-collected nontarget arthropods captured in cue-lure baited bucket traps in the AWPM implementation sites.

Materials and Methods

Each bucket trap (Uchida et al. 1996) was loaded with 2 ml of cue-lure on a wick and a toxicant (DDVP vapor tape; Hercon Environmental Company, Emigsville, PA 17318-0467; 10.75 % active ingredients) attached inside each trap. Traps were serviced at 2 to 4 week intervals. Captured arthropods were collected in a paper bag, separated from melon flies, stored in alcohol, and prepared for identification. Identifications were made to the lowest taxonomic level possible by the senior (G. K. U.) and fourth (B. R. K.) authors.

Ten traps were placed throughout each AWPM implementation site in Kula, Maui Island and Kamuela, Hawaii Island (Figs. 1 & 2) adjacent cultivated and uncultivated melon fly host plants in and around farms, where other bucket traps were in place for monitoring and suppression of male melon flies. Implementation sites in Kula and Kamuela were divided into a forty- and forty-two-block grid, respectively, with each block one km² in size. The

Figure 1. Trap sites (10) in Kula, Hawaii Island, Hawaii.

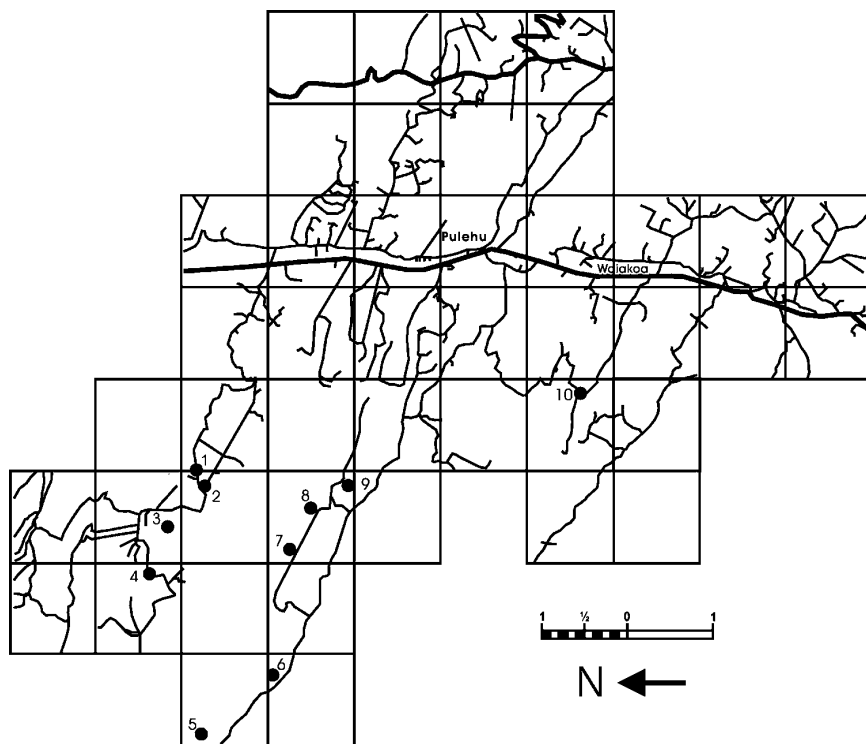
Kula (244–1158 m elevation) and Kamuela sites (695–1088 m elevation) are disturbed habitats consisting of farms, pastures, houses, and nonnative forests. Traps were sampled from November 7, 2001 to January 15, 2002 at Kamuela and November 21, 2001 to January 23, 2002 at Kula.

Results and Discussion

In Table 1, identified specimens are grouped by resident status (Nishida 2002) as adventive (Nishida 2002), endemic, indigenous (Eldredge and Miller 1995), beneficial (Borror et al. 1976), or purposely introduced (Funasaki et al. 1988). The known distributions of captured species are provided (Nishida 2002). The feeding habit groupings used are saprophagous, phytophagous, and zoophagous (Borror et al. 1976).

The nontarget taxa captured at both sites were representative of four classes, ten orders, 42 families, and 39 determined species (Table 1). Traps at the Kula site captured about 1.1 individuals per day (total = 70 specimens), whereas traps in Kamuela captured about 34.3 individuals per day (total = 2,368 specimens). On a per day basis, cue-lure baited traps captured relatively low numbers of individuals, but over a period of time this number increased many fold for some species. But, as with methyl eugenol baited traps targeting oriental fruit flies, it is necessary to lower the environmental risk by reducing the number of captured species (Howarth and Howarth 2000).

Among all captured arthropods at both sites, there were 36 adventive, ten endemic, zero indigenous, three purposely introduced, zero beneficial, and 33 undetermined species. Kamuela and Kula sites are highly altered environments with very few endemic plants. The low trap catch of endemic species probably reflects a reduced density of native arthropods due to the mixed agriculture-residential nature of the sites, the prevalence of invasive weeds, and the distance from any large areas of native habitat. Endemic species were 2.4% of the total captured.

Figure 2. Trap sites (10) in Kamuela, Hawaii Island, Hawaii.

Among the total number of captured species at both sites with known feeding habits, 57.3% were saprophagous, 24.4% zoophagous, and 9.8% phytophagous; and in terms of the total number of captured individuals at both sites, 92.5% were saprophagous, 5.7% phytophagous, and 1.8% zoophagous. The high percentage of saprophagous species and individuals indicated that captured rotting insects were attractive to nontarget insects. Loope and Medeiros (1992) hypothesized that captured rotting insects in methyl eugenol traps may have contributed to the attraction of nontarget insects and recommended that oriental fruit flies be excluded from traps in future experiments. Kido et al. (1996) found that insects in riparian stream habitats were attracted to methyl eugenol, but there was a secondary attraction to dead captured insects. Researchers have added ethylene glycol to traps as a preservative to remove the influence of rotting insects and determined that protein hydrolysate bait and methyl eugenol were attractive to nontarget insects (Asquith and Kido 1994, Asquith and Messing 1992, Asquith and Burny 1998, and Howarth and Howarth 2002). However, G. K. U. (unpublished data) found evidence that ethylene glycol also is attractive to nontarget insects and discovered mineral oil to be a better substitute.

Attraction of nontarget species to cue-lure baited traps shows a need for future improvements in trap design to reduce the number of captured arthropods and mitigate the effect of rotting insects. A proposed solution to reduce the catch of nontarget species is to use open bottomed male annihilation devices or monitoring traps with mineral oil to suppress the rotting of both target and nontarget insects.

Table 1. Nontarget species of arthropods captured in cue-lure baited fruit fly traps in the AIPM implementation sites on the islands of Maui (Kula) and Hawaii (Kamuela), November, 2001–January, 2002.

CLASS Order Family Species	Residency status ¹	Feeding habit ²	Known Hawaiian distribution ³	No. captured		
				Kula	Kamuela	Total
ARACHNIDA						
Araneae						
Family?						
sp. A?	?	Z	H	0	1	1
sp. B?	?	Z	H	0	3	3
sp. C?	?	Z	H	0	1	1
spp.?	?	Z	H	0	10	10
Salticidae						
<i>Phidippus audax</i> (Hentz)	A	Z	K, O, M, H	0	2	2
sp.?	?	Z	H	0	1	1
spp.?	?	Z	H	3	0	3
ELLIPURA						
Collembola						
Family?						
sp.?	?	S	M	1	0	1
INSECTA						
Coleoptera						
Anobiidae						
<i>Ozognathus</i> sp.						
poss. <i>exiguus</i> (Gorham)	A	S	O, M	43	0	43
<i>Tricorynus sharpi</i> (Pic)	E	S	O, M	1	0	1
Bruchidae						
<i>Acanthoscelides macrophthalmus</i> (Schaeffer)	A	P	O, M	31	0	31
Coccinellidae						
<i>Coelophora inaequalis</i> (Fabricius)	PI	Z	K, O, Mo, L, M, H	0	1	1
sp. A? (larvae)	?	Z	M	3	0	3
sp. B?	?	Z	M	2	0	2
<i>Telsimia nitida</i> Chapin	PI	Z	K, O, Mo, L, M, H	3	0	3
Mycetophagidae						
<i>Typhaea stercorea</i> (L.)	A	S	K, O, M, H	1	0	1
Nitidulidae						
<i>Carpophilus hemipterus</i> (L.)	A	S	K, O, Mo, L, M,	1	0	1
<i>C. mutilatus</i> Erichson	A	S	O	7	0	7
<i>Nesopetinus scottianus</i> Sharp	E	S	H	0	1	1
Scolytidae						
<i>Xylosandrus compactus</i> (Eichhoff)	A	S	K, O, Mo, L, M, H	3	0	3
Staphylinidae						
sp. A?	?	Z	H	0	1	1
sp. B?	?	Z	M	1	0	1

CLASS Order	Family Species	Residency status ¹	Feeding habit ²	Known Hawaiian distribution ³	No. captured		
					Kula	Kamuela	Total
Diptera							
	Anthomyiidae						
	<i>Delia echinata</i> (Seguy)	A?	?	M, H	7	2	9
	Culicidae						
	sp.?	A	Z	M	3	0	3
	Drosophilidae						
	<i>Chymomyza procnemis</i> (Williston)	A	S	O, Mo, L, M, H	4	0	4
	<i>Drosophila</i> (<i>Sophophora</i>) <i>ananassae</i> Doleschall	A	S	K, O, H	11	5	16
	<i>D. hydei</i> Sturtevant	A	S	K, O, Mo, L, M, H	3	0	3
	<i>D.</i> (<i>Sophophora</i>) <i>melanogaster</i> Meigen	A	S	K, O, Mo, L, Kh, M, H	10	3	13
	<i>D.</i> (<i>Sophophora</i>) <i>simulans</i> Sturtevant	A	S	K, O, Mo, L, M, H	1	1	2
	<i>D.</i> sp.	?	S	M	4	0	4
	<i>D.</i> spp.?	?	S	M	2	0	2
	Family?						
	sp. A?	?	?	M	1	0	1
	sp. B?	?	?	M	1	0	1
	sp. C?	?	?	M	1	0	1
	Lonchaeidae						
	<i>Lamprolonchaea</i> <i>metatarsata</i> (Kertesz)	A	S	K, O, Mo, M, H	1	0	1
	<i>Lonchaea polita</i> Say	A	S	O, M, H	2	0	2
	<i>L. striatifrons</i> Malloch	A	S	Mo, L, M, H	7	0	7
	Micropezidae						
	sp.?	A	S	M	1	0	1
	Milichiidae						
	<i>Desmometopa inaurata</i> Lamb	A	S	K, O, Mo, L, M, H	1936	1	1937
	Muscidae						
	<i>Atherigona orientalis</i> Schiner	A	S	K, O, Mo, L, M, H	3	1	4
	<i>Musca domestica</i> Linnaeus	A	S	K, O, Mo, L, M, H	1	1	2
	Mycetophilidae						
	spp.?	?	S	M, H	0	6	6
	Otitidae						
	<i>Euxesta annonae</i> (Fabricius)	A	S	K, O, Mo, L, M, H	2	0	2
	<i>Notogramma</i> <i>cimiciforme</i> Loew	A	S	K, O, Mo, L, M,	3	0	3
	sp.?	A	S	M	10	0	10
	Phoridae						
	<i>Megaselia</i> nr. <i>brunneipalpata</i> Beyer	E	S	M, H	14	0	14
	<i>M.</i> runs nr. <i>heterodactyla</i> Beyer	E	S	M	6	0	6
	<i>M.</i> species no. 2 (Hardy 1964)	?	?	M, H	35	0	35
	<i>M. scalaris</i> (Loew)	A	S	K, O, Mo, L, M, H	2	0	2
	<i>M.</i> spp.?	?	S	M	30	0	30
	Psychodidae						
	<i>Psychoda alternata</i> Say	A	S	K, O, Mo, M, H	3	0	3

Table 1 (continued).

CLASS Order	Family Species	Residency status ¹	Feeding habit ²	Known Hawaiian distribution ³	No. captured		
					Kula	Kamuela	Total
	<i>P. sp. A?</i>	?	S	M	2	0	2
	<i>P. sp. B?</i>	?	S	M	1	0	1
	Sarcophagidae						
	<i>Sarcophaga peregrina</i> (Robineau-Desvoidy)	A	S	K, O, Mo, L, M, H	2	0	2
	Scatopsidae						
	<i>Psectrosiara brevicornis</i> Johannsen	A	S	O, Mo, M	16	0	16
	sp.?	?	S	M	1	0	1
	Sciaridae						
	<i>Lycoriella hoyti</i> (Hardy)	E	S	O, Mo, M, H	19	1	20
	sp.?	?	S	M	0	1	1
	Syrphidae						
	<i>Copestylum tamaulipanum</i> (Townsend)	A	S	K, O, Mo, L, M, H	1	0	1
	Tipulidae						
	<i>Limonia</i> sp.?	E	?	H	0	2	2
Heteroptera							
	Miridae						
	? <i>Kalania</i> sp.?	E	?	H	0	2	2
	<i>Pycnoderes quadrimaculatus</i> Guerin-Meneville	A	P	K, O, Mo, M, H	1	2	3
	Reduviidae						
	<i>Zelus renardii</i> Kolenati	A	Z	K, O, Mo, L, M, H	3	0	3
Homoptera							
	Aphididae						
	sp.?	?	P	M	3	1	4
	Cicadellidae						
	sp.?	A	P	H	0	1	1
	<i>Sophonia rufofascia</i> (Kuoh and Kuoh)	A	P	K, O, Mo, L, M, H	0	1	1
	Psyllidae						
	<i>Heteropsylla cubana</i> Crawford	A	P	K, O, Mo, L, M, H	89	0	89
Hymenoptera							
	Bethylidae						
	<i>Epyris</i> sp.?	?	Z	M	2	0	2
	Chalcididae						
	<i>Dirhinus anthracia</i> Walker	PI	Z	O, Mo, M, H	1	0	1
	Eupelmidae						
	<i>Eupelmus</i> sp. A?	?	Z	M	1	0	1
	Evaniidae						
	<i>Szepligetella sericea</i> (Cameron)A?		Z	K, O, Mo, L, H	0	1	1

CLASS Order Family Species	Residency status ¹	Feeding habit ²	Known Hawaiian distribution ³	No. captured		
				Kula	Kamuela	Total
Lepidoptera						
Family?						
sp. A?	?	P	H	3	2	5
sp. B?	?	P	H	0	1	1
Psocoptera						
Family?						
sp. A?	?	S	M	7	0	7
sp. B?	?	S	M	8	0	8
sp. C?	?	S	M	1	0	1
Hemipsocidae						
<i>Hemipsocus roseus</i> (Hagen)	A	S	O, L, M	3	0	3
Psocidae						
<i>Ptycta</i> sp. A?	E	S	H	0	6	6
<i>P.</i> sp. B?	E	S	H	0	1	1
<i>P.</i> sp. C?	E	S	H	0	4	4
GASTROPODA						
Pulmonata						
Family						
<i>Subulina octona</i> (Bruguiere)	A	S	H	0	3	3
	Total	2,371	70	2441		

¹Residency status: E = endemic; A = adventive; PI = purposely introduced; ? = unknown.
²Feeding habit: Z = zoophagous; P = phytophagous; S = saprophagous; ? = unknown.
³Known Hawaiian distribution: K = Kauai Island; O = Oahu Island; M= Maui Island, Mo = Molokai Island; L = Lanai Island; Kh = Kahoolawe Island; H = Hawaii Island.

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